

Field Sampling Plan

for

Lower Silver Creek, Summit County, Utah

Prepared for:

U.S. Environmental Protection Agency Region 8
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DISTRIBUTION

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1. INTRODUCTION AND BACKGROUND

This Field Sampling Plan (FSP) supports the field work performed by Tetra Tech as a contractor of the U.S. Environmental Protection Agency (EPA) in the Lower Silver Creek (LSC) Site corridor for the Silver Creek Load Reduction Alternatives Assessment. Tetra Tech is performing this work for EPA under Contract Number 68-C-02-108. The field activities will be performed from August to December of 2007.

Following guidance provided in Title 40 of the *Code of Federal Regulations* section 300.430(b)(8)(i) and (ii), this FSP represents one of the two documents that compose the Sampling and Analysis Plan covering Tetra Tech's field work. The FSP provides guidance for field personnel by defining, in detail, the number, type, and location of samples to be collected; and the type of analyses to be performed. This FSP follows the general guidelines for developing FSPs presented in USEPA (1988). This FSP is intended to be used with the companion Quality Assurance Project Plan (QAPP). The QAPP describes the policy, organization, functional activities, and quality assurance (QA) and quality control (QC) protocols employed to verify that the data and measurements collected achieve the specified data quality objectives. This FSP was developed for Tetra Tech and approved Tetra Tech contractors to use. The companion QAPP document was developed by the Utah Department of Environmental Quality, Division of Environmental Response and Remediation (UDEQ DERR) and approved by EPA Region 8 personnel.

Tetra Tech will provide the majority of the technical and field staff to perform the sampling and reporting aspects of the individual tasks related to this work. Tetra Tech will subcontract with qualified subcontractors to perform the following specific tasks:

- Analytical services will be performed by the following: soil nutrient, organic matter, and paste pH analyses by Colorado Analytical of Brighton, Colorado; physical and engineering soil properties by Rock Sol of Boulder, Colorado; and groundwater iron analysis by ACZ Laboratories, Inc., of Steamboat Springs, Colorado.
- The Laboratory for Environmental and Geological Studies (LEGS) at the University of Colorado, Boulder will perform soil mineralogy analysis.
- Clement Drilling and Geophysical, Inc., will provide drilling and piezometer installation services.

Tetra Tech's Fort Collins office will perform X-ray fluorescence (XRF) analysis of soil samples. An approved EPA Contract Laboratory Program (CLP) facility will perform inorganic surface water, groundwater, and soil (QA) analyses on the samples collected by Tetra Tech personnel. The EPA Environmental Services Assistance Team (ESAT) in Golden, Colorado, will perform sulfate and total suspended solids analyses.

1.1 Project/Task Organization

The organizations and individuals participating in the project are shown in the organizational chart below (Figure 1). EPA Region 8 has ordered the field tasks to be performed for this project. EPA's Task Order Manager is Kathryn Hernandez. The EPA's Quality Assurance Office is Anthony Medrano. The EPA personnel will be responsible for final review and approval of Tetra Tech's proposed field activities.

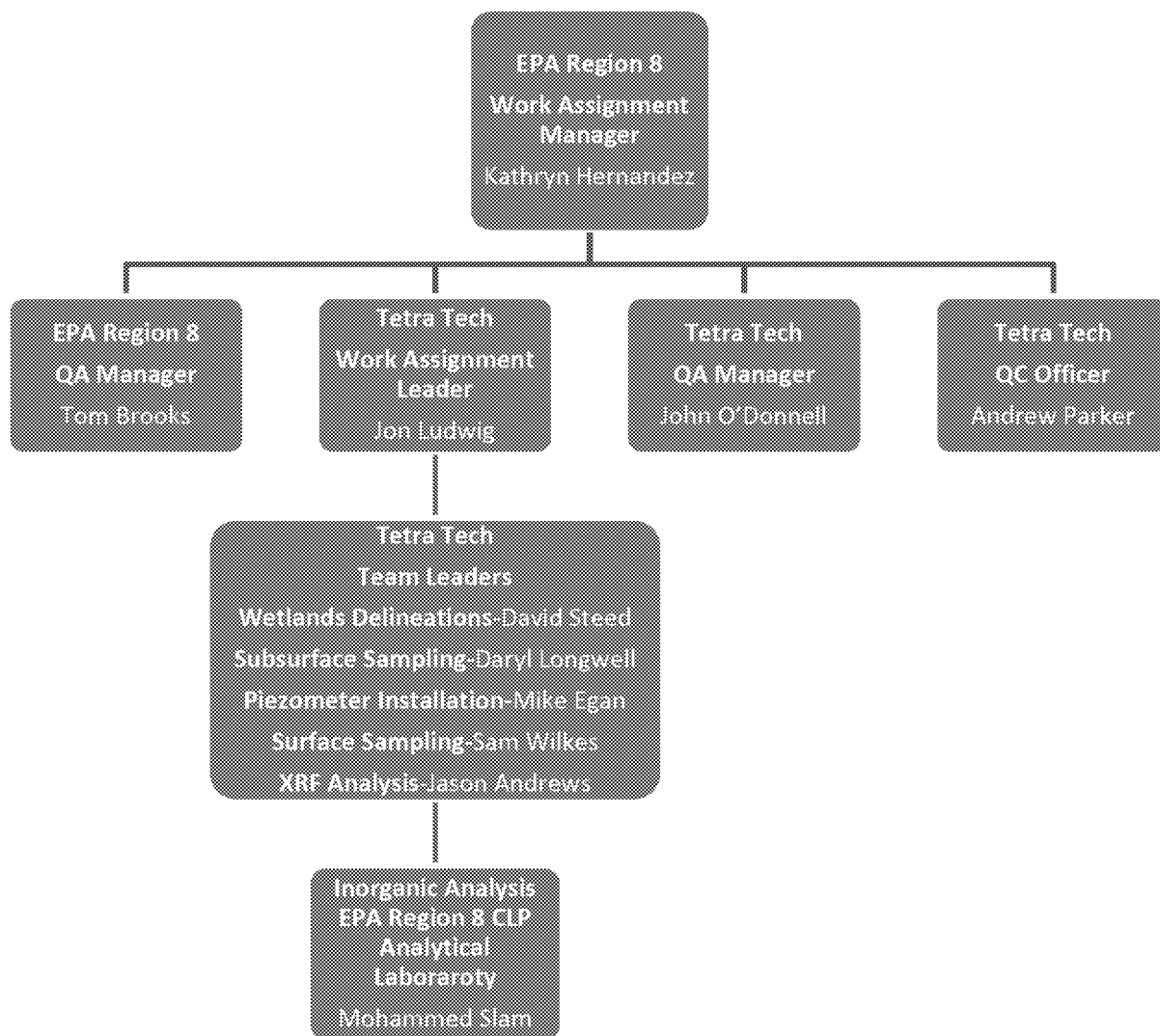


Figure 1. Project organization chart.

The Tetra Tech Co-Task Order Leaders are John Craig and Jon Ludwig. Jon Ludwig is serving as the Project Manager assisting John Craig and handling daily management activities. John O'Donnell is the quality assurance manager and he will be assisted by Andrew Parker as the quality control officer. Subtask leaders are David Steed for the wetlands delineation; Daryl Longwell and Mike Egan for subsurface exploration and piezometer installation; and Sam Wilkes for surface soils, surface and groundwater, and sediment sampling. Tetra Tech's intercompany activities are governed by intercompany agreements.

Tetra Tech will subcontract the entities named in section 1.0 above to perform certain field and standard analytical tasks. An EPA CLP facility is responsible for the inorganic groundwater analyses and the EPA's ESAT lab is responsible for sulfate and total suspended solids analyses.

1.2 Background

Silver Creek is in Summit County, Utah. Silver Creek flows from the headwaters upstream of Park City into the Weber River, near Wanship, Utah. The creek is fed by precipitation (snowmelt), groundwater, springs, and mine tunnel discharges near the headwaters. This project addresses the approximate 5-mile reach of LSC from north of Highway 248 to I-80. The stream flows between Highway 40 to the west and the Union Pacific Rail Trail to the east in this reach. The site includes the floodplain and riparian habitat and upland areas adjacent to Silver Creek. The LSC Site is up to 3,800 feet (ft) wide. The region is undergoing significant development.

Silver Creek is classified for beneficial use Class 3A for protection of cold water fish and cold water species (UDEQ DWQ 2004). Water rights for domestic water, stock, irrigation, and recreation are held by public and private entities. The LSC Site is flood irrigated, and the stream is affected by irrigation runoff and groundwater return flows. Several irrigation ditches have been constructed in the basin. U.S. Geological Survey (USGS) stream flow gaging station 10129900 is in the LSC Site downstream of the Snyderville Water Reclamation Facility outfall.

Mining in the Park City area began around 1869. The first shipment of ore, 40 tons, was transported out by rail in July 1870 (UDEQ DERR 2002). As many as 10 mills operated along the banks of Silver Creek throughout the history of mining in Park City. Tailings from the mining operations were washed downstream and deposited in over-bank deposits in the floodplain throughout the LSC Site. Irrigation diversions might have spread the tailings or affected Silver Creek waters to areas outside the floodplain. The Big Four Mill near the present Pivotal Promontory access road was the primary mill operating within the LSC Site. The mill was erected to process the zinc-lead-silver tailings accumulated in the LSC flats (Williams 1916). The Big Four was said to be the third largest mill in Utah in 1916, consisting of a 2-month stockpile of 50,000 tons of ore and the capacity to process 1,800 tons of ore tailings per day (UDEQ DERR 2002). The mine operated from 1915 to 1918. The Big Four tailings field was reportedly 3.5 miles long by 400- to 1,200-ft wide and 2 inches to 8 ft deep. Today, the tailings exist in mounds, berms, and hummocks. There are two Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) listed sites upstream of the LSC Site—Richardson Flat and Empire Canyon.

The Utah Division of Water Quality (UDWQ) and USGS have monitored the site for more than 13 years. Silver Creek is listed on Utah's 303(d) list as impaired with a high ranking because of elevated concentrations of zinc and cadmium. In 2004 UDWQ published a total maximum daily load (TMDL) report in which Silver Creek was listed as impaired by zinc and cadmium because both constituents exceeded the 4-day chronic aquatic-life standards (UDEQ DWQ 2004). Soils metal concentrations are also a concern. Lead and arsenic are the risk drivers for soil contamination. UDEQ completed an Innovative Assessment in 2002 on the LSC Site; on the basis of elevated lead and arsenic concentrations, UDEQ recommended the LSC Site for CERCLIS listing.

The Silver Creek watershed is a joint EPA water and waste program site. The initial TMDL assessment included gross (watershed-scale) load allocations and provided a summary of best management practices (BMPs) to reduce loading. Estimates for non-location-specific source control measures were nearly \$100 million. However, the TMDL report was not intended to provide sufficient level of detail necessary to justify the expense of specific source-reduction and remediation

efforts. This study will provide additional water quality and soils data, analysis, and modeling to describe the nature and extent of mine waste and metals loading and transport pathways. The goal of the study is to build on previous watershed-level analyses and TMDL work to review, assess, and provide a combination of management options that maximize the efficiency (pollution reduction and cost) of restoration efforts in the watershed.

The Silver Creek project is part of a larger effort by EPA Region 8 to promote cross-program coordination to better focus resources on protection and restoration. To support that effort, EPA Region 8 recently led the development of a cross-programmatic watershed manual, *Integrating Water and Waste Programs to Restore Watersheds* (USEPA 2007). The goal of the manual is to enhance coordination across EPA waste and water programs to streamline requirements, satisfy multiple objectives, tap into a variety of funding sources, and implement restoration activities more efficiently, showing measurable results. The manual provides guidance on how to integrate assessment and cleanup activities to optimize available tools and resources and help restore contaminated waters efficiently and effectively.

1.3 Contaminant Generation and Pathways

The LSC Site is in a low-gradient valley surrounded by small hills. Erosion and weathering of the Keetley Volcanic hills formed the valley's original soil surface (USEPA 2005). Mine tailings generally cover the entire riparian habitat on the southern portion of the LSC Site from Highway 248 to near the Synderville Water Reclamation Facility. The lateral extent and thickness of the tailings deposits are largely unknown. Tailings are visually apparent in the nonvegetated, gray colored sandy or gravelly mounds and low berms in the riparian habitat along LSC (UDEQ DWQ 2004). Elongated berms are throughout the entire southern portion of the LSC Site and are oriented from the north to south. In some areas, soil cover is thin or absent, and tailings are exposed to the surface (USEPA 2005).

Vegetation in the southern portion of the LSC Site is dominated by primary grass and sedge species and one tree. The sedge species grows in the drier areas surrounding the nonvegetated mounds and berms. This hardy sedge is reportedly not palatable to the livestock and grows to 1 to 2 ft high. The livestock prefer the grass species found in the wetter areas (drainages and flood irrigated hummocks) and on the uplands. Several trees and a frog species were introduced to the area near Pivotal Promotory Road as part of a wetlands mitigation project, and neither the trees nor the frogs survived. The failed introduction of those species was apparently due to poor soil conditions reportedly resulting from metals toxicity. The northern portion of the LSC Site is generally well-vegetated (UDEQ DWQ 2002).

The chemicals of concern (COCs) at the LSC Site are zinc, cadmium, lead, and arsenic. The media affected by those contaminants are surface water, groundwater, sediment, and soils. Contamination in the media could affect ecological receptors (zinc, cadmium, and lead) and humans (lead and arsenic). TMDL reductions are required for surface water cadmium and zinc. The COCs in sediment and soil are lead and arsenic. Soil disturbance caused by natural events, development or direct contact could result in exposure to COCs by any combination of ingestion, dermal exposure, or inhalation.

Metals in LSC originate from sulfide mineral bearing ore deposits in the Park City Mining District. Some ores stem from skarn deposits hosted in carbonate rocks. Carbonate minerals also occur in intrusions as gangue minerals. Tailings from those ores should thus be abundant in sulfide and carbonate minerals (Utah Geological Society 1968) and (USGS 1989). Mineralogical analyses have

not been performed at the LSC Site to date. Tetra Tech plans to perform a general mineralogical analysis.

Surface and groundwater transport are likely the predominate methods by which metals are transported in LSC. The typical mechanism for metals release in mining-affected streams is metal liberation resulting from exposure to acidic conditions. Acid is generated through oxidation of sulfide minerals, typically pyrite, which initially requires both oxygen and water to proceed. The oxidation reaction can be catalyzed by bacteria, as in the case of pyrite oxidation by the iron-oxidizing bacterium *Thiobacillus ferrooxidans*. The products of pyrite oxidation are iron ions, sulfate, and hydrogen ion (low pH). The formation of sulfuric acid enhances mineral weathering, which, in turn, promotes metal availability. Many metals, aluminum, cadmium, copper, iron, manganese and zinc included, are more mobile in low pH (acidic) water. Without sufficient buffering capacity, the formation of sulfuric acid leads to the generation of acid mine drainage. LSC generally has a neutral pH ranging from 7.5 to 8.0 indicating that low levels of pyrite are present in the tailings or it is well buffered by the presence of carbonate minerals (or both).

In 2002 USGS performed a tracer study in LSC, which showed that inflows to LSC had lower pH and higher metals concentrations than those in the mainstem. As inflows enter LSC and pH increases because of mixing with the mainstem waters, metals likely precipitate and settle into the stream sediment or move downstream in the particulate (e.g., sediment) form.

The practice of flood irrigation might be mobilizing metals from soils and tailings piles and serving as a metals transport pathway to LSC. Groundwater inflow to LSC is expected to be significant. Contaminants could be introduced to the LSC through the groundwater system. The extent of groundwater and surface water interaction in LSC is poorly understood because extensive studies have not been performed. Tetra Tech plans to measure metals concentrations and reduction-oxidation potential in the groundwater and to characterize the piezometric surface of the LSC Site.

1.4 Project Description

This FSP covers work to be performed during a two-phased field effort during 2007. The program encompasses work to collect and analyze soil samples, groundwater samples, surface water and sediment samples, perform surface water flow measurements, and conduct a wetlands delineation. Tetra Tech will use a two-phased field strategy for data collection. Information collected during Phase I will be used to streamline data collection during the second phase of work.

During Phase I, six transects spanning the study area will be delineated in the LSC valley (Figures 2 and 3). Two landforms will be sampled across each transect—the floodplain area and the uplands area.

Sampling stations will be every 250 ft across the floodplain portion of each transect and every 500 ft in the uplands areas. At each transect between 2 and 12 sample stations are in the floodplain area and between 1 and 5 sample stations are in the uplands. A Geoprobe will be used in the floodplain area to collect subsurface soil samples and to assess the thickness of tailings material. In areas where tailings are present, samples will be collected from the tailings profile and from the material underlying the tailings, if practicable. The Geoprobe investigation will help quantify the volume of tailings in LSC. Soil samples will be collected at upland locations from the 0- to 6-inch depth interval if tailings material is not visibly apparent.

XRF analysis will be performed on soil samples to quantify soil metal concentrations for arsenic, cadmium, lead, and zinc. XRF analysis will be performed in Colorado after sampling is complete.

Nutrient, paste pH, acid-base accounting, and organic analyses will be performed on 10 surface soil samples. Mineralogical analysis will be performed on two samples.

Several 5-gallon bulk soil samples will be collected and used to characterize the physical and engineering properties of the soil. The soil will be classified and geotechnical parameters will be measured.

Two to four one-inch diameter piezometers will be installed on each transect to provide insight on the direction of groundwater flow and groundwater chemistry. Piezometers will generally be within the floodplain area. The piezometers will be surveyed by a professional surveyor. The floodplain and uplands sample locations will be surveyed with a handheld global positioning system (GPS) unit.

Phase I will also include a wetlands delineation of the LSC Site.

Phase II will consist of additional XRF sampling to supplement that performed during Phase I. Phase II will also include low-flow surface water, sediment, and groundwater sampling to support the metals transport modeling.

2. PROJECT OBJECTIVES AND MEASUREMENT PERFORMANCE

The primary purpose of the LSC Load Reduction Alternatives Assessment is to provide environmental data to support evaluations of the effectiveness of various practical remedial alternatives and management strategies to maximize restoration efforts. To that end, data quality objectives (DQOs) were developed to guide the type, quantity, and quality of the data collected.

2.1 Data Quality Objectives

The DQOs for the project work were developed using the systematic planning process described in the EPA document *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4 (USEPA 2006). The following steps are included in the EPA's process:

- Step 1. State the Problem
- Step 2. Identify the Project Goals
- Step 3. Identify the Inputs
- Step 4. Define the Boundaries of the Study
- Step 5. Develop the Analytic Approach
- Step 6. Specify Performance/Acceptance Criteria

Step 1. State the Problem

The LSC Site has been listed on Utah's 303(d) list as impaired with a high ranking because of elevated levels of zinc and cadmium in Silver Creek. Additionally, Summit County, Utah, is working to develop and implement a soils ordinance for the LSC Site to inhibit exposure and thereby limit detrimental health effects because of potentially elevated lead and arsenic soils concentrations.

On the basis of previous studies, estimates for non-location-specific source control measures in the LSC were nearly \$100 million. The previously assessed alternatives were primarily based on either complete isolation of materials from stream flow or removal of all materials from the stream

throughout extended segments of Silver Creek. A comprehensive review, assessment, and quantification of load reduction alternatives is needed to develop practical and cost-effective approaches for reducing the threat posed by legacy mine wastes to human health and the environment in LSC.

The goal of this study is to build on previous watershed-level analyses and planned data collection efforts to develop a series of BMPs that maximize efficiency (pollution reduction and cost) of restoration efforts in the watershed. The data collected in the field will be used to compare and quantify various source-reduction options and associated cost scenarios. Tetra Tech will develop an approach with applicability to other mining-affected waters in the western United States. The assessment and modeling approach will allow for the following:

- Targeted identification of the most significant sources of metals loadings to the stream
- Quantification of metals loads
- Development of a matrix of source controls (BMPs) and their expected load reduction
- Evaluation of cost and effectiveness of multiple source control alternatives

EPA will review and approve the project report, which will then be made available to the LSC stakeholders for use as they develop their properties.

Step 2. Identify the Project Goals

The project goal is to develop a series of remedial alternatives to provide landowners, developers, and public entities with practical methods to address mine waste contamination on their properties. Tetra Tech will identify best practices to (1) reduce zinc and cadmium loading to Silver Creek to meet aquatic life standards and reduce ecological risk by lowering lead concentrations in sediment, (2) support Summit County's development of their Soils Ordinance (lead and arsenic), and (3) ensure no net loss of wetlands. The remedial alternatives assessment will be accomplished using an integrated approach that will serve as a case study for the EPA's Region 8 manual, *Integrating Water and Waste Programs to Restore Watersheds* (USEPA 2007).

Step 3. Identify the Inputs

The results of the field study identified in this document, combined with data from *Principal Locations of Metal Loading from Floodplain Tailings, Lower Silver Creek, Utah, April 2004* (USGS 2004), will provide the basis for the decision. The surface water, sediment, and groundwater results will serve as inputs to the metals transport model. The model will allow quantification of metals inputs to LSC (upstream sources, LSC sources [floodplain tailings, metals mobilized through flood irrigation], groundwater inputs). Predictive model runs will allow assessment of the effectiveness of proposed remedial alternatives that could include stream relocation, source removal and relocation to a repository, and capping of tailings piles.

The soils analyses will quantify metals concentrations and extent (lateral and horizontal) of contamination. Results of the analyses will also assist Summit County in setting action levels for lead and arsenic for the Summit County soils ordinance.

Step 4. Define the Boundaries of the Study

The southern boundary of the study area is Highway 248, just north of the Richardson Flat CERCLIS site. The northern boundary of the study area is I-80. The LSC study boundary includes the entire LSC floodplain and adjacent uplands areas. The study area ranges in width from 2,100-ft wide at the

southern boundary near Highway 248- to 3,800-ft wide on the northern end of the study area near Pivotal Promontory Road. The area of the LSC Site is approximately 3 square miles. Phase I soil sampling will be concentrated along six transects spanning the study area (Figures 2 and 3). Phase II soil sampling will be dispersed throughout the entire study area. Surface water and sediment samples will be taken along the stream corridor and from irrigation ditches within the study area.

The majority of the LSC Site is open pasture used for livestock grazing. Some commercial properties are on the west side of LSC including a cement plant, the Summit County Sheriff's Department, and the Synderville Water Reclamation Facility. The Pivotal Promontory residential community is on the east side of the LSC Site and is experiencing rapid development.

Step 5. Develop the Analytical Approach

The analytic approach will involve the comparison of the sample results to the applicable Utah water quality standard (WQS). In cases where the sample result exceeds the WQS, the relative contributions of the contaminant from individual sources in the site and from the upstream sources will be calculated.

Utah, Rule R317-2-14 states that the standards for zinc and cadmium are dependent on the hardness of the water. Water quality criteria to protect aquatic life can be calculated at in situ stream hardness up to a maximum hardness of 400 milligrams per liter (mg/L) as calcium carbonate (CaCO₃). The average hardness measured in the Silver Creek watershed is 484 mg/L (UDEQ 2004). Table 1 provides the WQS in effect in LSC calculated on the basis of a hardness of 400 mg/L. The chronic WQS has been adopted in Silver Creek according to Utah's adoption of chronic criteria for waters listed in the 303(d) process.

Table 1. Water quality standards for Silver Creek

	Hardness-based chronic formula	Chronic (mg/L)
Zinc	$e^{(0.84/3(\ln(\text{hardness})) + 0.884)}$	0.39
Cadmium	$e^{(0.7409(\ln(\text{hardness})) - 4.719)}$	0.0008

Notes: Chronic hardness values were calculated on the basis of a hardness of 400 mg/L as CaCO₃

Zinc concentrations as high as 1,070 mg/L and cadmium concentrations as high as 2.0 mg/L have been measured at the LSC Site. Because zinc and cadmium concentrations at the LSC Site grossly exceed WQS, the data results and subsequent remedial alternatives will allow decision makers to select the most appropriate remedial option on the basis of the anticipated net water quality benefit and cost effectiveness. Tetra Tech will use reactive transport modeling to predict the resultant zinc and cadmium concentrations for the various remedial alternatives under both high- and low-flow conditions.

The soils data will provide Summit County with information of the level and spatial extent of soils metal contamination on the LSC Site. The EPA Health Based Risk Standard for lead is 400 parts per million (ppm); the UDEQ Voluntary Cleanup Program has adopted that value as its benchmark for remediation. Park City has adopted a Soils Ordinance for properties affected by mine wastes. Affected property owners are required to cap the lot with 6 inches of clean topsoil and a vegetation layer. The clean topsoil must not contain more than 200 ppm lead for occupied properties. *Vacant properties*, as defined by the Park City Building Department, must not contain more than 1,000 ppm. Summit County might adopt a Soils Ordinance with similar action levels. The soils data collected

during this project will assist Summit County in establishing the action level land boundaries for its soils ordinance. It is assumed that any action to reduce soils lead concentration to less than the threshold value will also reduce arsenic soils concentration to acceptable levels.

Step 6. Specify Performance/Acceptance Criteria

Regardless of the care taken when collecting and analyzing environmental samples, acceptable levels of variance could result in reported concentrations that are slightly above or below the actual concentrations. The use of documents such as this FSP and the companion QAPP are intended to minimize such variance.

The tolerance limits for the decision rules will be set at a level consistent with the evaluation of duplicate samples, as described in the EPA document *National Functional Guidelines for Inorganic Data Review* (USEPA 2002). Specifically, the measured concentrations of samples collected in the field will be compared to WQS or action level using the relative percent difference, or RPD, method as described below:

$$\text{Relative Percent Difference (RPD)} = \frac{|WQS - \text{Sample Value}|}{(WQS + \text{Sample Value}) \div 2} \times 100$$

Following the EPA guidance, a control limit of 20 percent will be used to assess the RPD values. Specifically, individual sample results that fall within the RPD envelop of the chronic WQS \pm 20 percent will be considered equivalent to the chronic WQS. Individual data points falling within the *gray area* defined by the tolerance limits indicates to the decision maker that the results are close to the target; continued monitoring (larger dataset) or a rigorous statistical analysis or both might be required.

2.2 Measurement Performance Criteria

The usability of the field and laboratory analytical data will be established through an evaluation of the precision, accuracy, representativeness, completeness, and comparability parameters. The components of the data usability assessments are described, in detail, in the companion QAPP.

3. SAMPLING LOCATION AND FREQUENCY

This section presents a description of the location and frequency of field activities. Field methods, sampling procedures, and QA/QC protocols are presented.

Modifications to the Phase II activities resulted from discussions between Tetra Tech and EPA Region 8 personnel on the basis of the results of the Phase I sampling and site conditions at the time of the Phase II sampling event. Modifications will include performing additional surface soil sampling (0- to 6-inch depth interval) in upland areas, shallow subsurface samples (6- to 12-inch depth interval) at select surface soil sample locations, installing additional piezometers for groundwater level measurement and sampling, and digging test pits in the floodplain area. Surface soil and shallow subsurface soil samples will be sent to a CLP facility using the ILM05.3 statement of work (SOW), which defines the analytical methods accepted by the CLP for the isolation, detection, and quantitative measurement of 23 target analyte metals (including mercury) in both water and soil/sediment samples. Analyses will be performed using ICP-AES or ICP-MS or both. Five Phase II upland surface soil samples will be analyzed for arsenic, cadmium, lead, and mercury using the Toxicity Characteristic Leaching Procedure.

Test pit samples will be sent to ACZ Laboratories for analysis of arsenic, cadmium, lead, zinc, soil pH, and neutralization potential. Ten test pit samples will be analyzed for acid base accounting analysis for acid base potential, acid neutralizing potential, and acid generating potential.

Groundwater samples will be sent to a CLP facility using the ILM05.3 SOW, which defines the analytical methods accepted by the CLP for the isolation, detection, and quantitative measurement of 23 target analyte metals (including mercury) in both water and soil/sediment samples. Analyses will be performed using ICP-AES or ICP-MS or both.

3.1 Soil Sampling

Soil sampling will be performed during Phase I and Phase II field work.

3.1.1 Sampling Locations Phase I

The soil sample locations were selected on the basis of current understanding of the study area using available physical information from various maps and related reports. During Phase I, six transects will be delineated in the study area and are shown in Figures 2 and 3. Two landforms will be sampled across each transect, the floodplain area (which is anticipated to include tailings) and the uplands area. Soil sample stations in the floodplain area will be at approximately 250-foot intervals, while soil sample stations in the upland area will be at approximately 500-foot intervals along the transects. As shown on Figures 2 and 3, each transect will have between 2 and 12 sample stations in the floodplain area and between 1 and 5 sample stations in the upland areas. The sample station locations will be surveyed with a handheld GPS unit.

3.1.2 Sampling Frequency Phase I

At sample stations in the floodplain, where tailings material is anticipated, the goal will be to collect representative samples of the surficial material, tailings/mine waste material and underlying native material. For planning purposes, samples will be collected through the tailings profile and from the subgrade underlying the tailings, if practical. The field team will have the flexibility to modify sampling locations, depths and number of subsurface samples collected on the basis of observations and depths of identified/suspected mine tailings or mine waste materials encountered. In the upland areas, soil samples will be collected from the 0- to 6-inch depth interval if tailings material is not visibly apparent. If tailings materials are encountered in upland areas, additional, deeper samples could be collected in the first native material encountered below any tailings. Each sample will be analyzed for arsenic, cadmium, lead, and zinc with a Niton XRF as described in Section 7. Table 2 breaks down the frequency of soil samples for the Phase I XRF analysis.

Table 2. Estimated number of phase I soil samples

Sample depth	Number of samples	
	Floodplain	Uplands
0-6 in (Surficial)	43	21
4-5 ft ^a (Tailings)	24	0
8-10 ft ^a (Native)	24	0
Total	91	21

a. Depths assumed for planning purposes.

In addition to the XRF samples described above, two to three 5-gallon bulk soil samples will be collected and used to characterize the physical and engineering properties of the soil. The soil will be classified, and the following geotechnical parameters will be measured: grain size analysis including the percent passing the #200 sieve, Atterberg limits, and moisture-density relationship.

Approximately 10 surface soil samples will also be selected for nutrient analyses. Those 10 samples will be selected from floodplain areas on transects 1, 3 and 5 (Figures 2 and 3) where tailings material is visibly apparent. In addition to the nutrient analyses, paste pH analysis, acid-base accounting, and organic matter analysis will be performed.

Mineralogical analyses will be performed on two soil samples at the University of Colorado's LEGS. Mineralogy can have a profound effect on metals bioavailability. The frequency of occurrence and relative metal mass of each metal-bearing mineral within each sample will be measured and depicted graphically on a frequency bar graph.

Additional XRF sampling will be performed during Phase II. The depths of the XRF sampling locations will be determined using the results of the Phase I XRF investigation.

3.1.3 Surface Soil Sampling Phase II

During the Phase II investigation, a total of 230 surface soil samples (0- to 6-inch depth interval) will be obtained to evaluate the presence of metals contamination in the upland areas adjacent to the floodplain. The samples will be collected on a 425-ft grid throughout the LSC site. Sample locations will be surveyed using a GPS unit with submeter accuracy. Sampling is scheduled to occur October 29 through November 10, 2007. Proposed sample locations are shown on Figures A and B.

3.1.4 Subsurface Investigation Phase II

The Phase II subsurface investigation will be composed of two parts. Shallow subsurface samples (6- to 12-inch depth interval) will be collected at selected surface soil sample locations. Deeper samples, varying in depth from 0.5 to 4 ft, will be collected from test pit locations in the floodplain area. The 6- to 12-inch sampling is scheduled to occur October 29 through November 10, 2007, while the test pit sampling is scheduled to occur November 5 through 10, 2007. A total of 26 samples will be collected from the 6- to 12-inch depth interval in select surface soil sampling locations. A total of 22 test pits will be dug to further delineate the extent of tailings material within the primary floodplain (tailings depositional) area. A total of 36 test pit samples will be collected. Test pit samples will be sent to ACZ Laboratories for metals and acid base accounting analyses. The University of Colorado will conduct lead speciation and mineralogical analysis on samples from four test pits. Sample locations are displayed on Figures 2 and 3. Each test pit will be documented by completing a test pit log form.

3.1.5 Geophysical Survey Phase II

A geophysical survey using Ground Penetrating Radar (GPR) will be conducted December 3 through December 7, 2007. The intended purpose of conducting the GRP survey is to determine if the results could be used to more accurately determine the depth and lateral extent of the tailings deposition areas. GPR is a geophysical technique that employs radio waves, typically in the 1 to 1,000 MHz frequency range to map structures and features (man-made and natural) buried in the subsurface. GPR operates on the simple principal that electromagnetic waves, emitted from a transmitter antenna, are reflected from buried objects and detected by the receiver antenna. GPR data is presented in the form of time-distance plots that are analogous to conventional seismic records that provide a cross-

sectional image or profile of reflections representing shallow subsurface conditions. It is anticipated that 52 transects will be taken at approximately 500-foot intervals across the floodplain/suspected tailings deposition area along the LSC Site.

3.1.6 Soil Sampling with Geo Probe Phase II

In the floodplain area, an all-terrain tractor-mounted GeoProbe will be used to direct push a 2-inch inside diameter continuous boring from the ground surface to the native subgrade below the tailings material. An experienced geologist will log the borings following protocols set forth in Appendix A-4, ASTM D5434-93 *Standard Guide for Field Logging of Subsurface Explorations of Soil and Rock*. Samples for laboratory analysis will be collected from up to three distinct horizons in each boring; the surface interval, the tailings, and the underlying native material. The number of samples collected is described in Section 3.1.2.

The surface soil samples (0- to 6-inch interval) in both the floodplain and upland areas will be collected with a dedicated plastic trowel. A metal spoon, shovel, hand spade, or pick could be used if needed to loosen the surface material. The sample will be collected from an approximate 4-inch by 4-inch area from the surface to a depth of 0 to 6 inches. Stones, pebbles, and organic matter will be removed from the sample. At the discretion of the field sampling personnel, samples could be collected with a decontaminated stainless steel trowel, hand spade, or spoon if hard-packed conditions preclude the use of the plastic trowel.

The affected soil and underlying native material samples in each boring will be collected using decontaminated equipment. The sample will be collected in a clean, re-closeable, freezer-type plastic storage bag (Ziploc®). The sample will be homogenized in the sample bag by kneading and hand-crushing of clods until the sample is thoroughly mixed. Each bag will be labeled with the sample identification number, sampler's initials, and the date and time of sample collection. The above information will also be recorded in the log book. General decontamination procedures for the equipment and geoprobe are described in Sections 5.6 and 5.7 and in Appendix A-5, EPA ERT Standard Operating Procedure (SOP) #2006, *Sampling Equipment Decontamination*.

For geoprobe borings not used to install a piezometer, the borings will be abandoned by sealing the hole with granular bentonite or other approved sealing agents.

3.2 Groundwater Sampling

Groundwater sampling will be performed during Phase I and Phase II field work.

3.2.1 Sampling Locations Phase I

Two to four one-inch diameter piezometers will be installed on each transect by the geoprobe subcontractor following the protocol described in Appendix A-1. Each piezometer will be constructed of 3/4-inch ID PVC with 3- or 5-foot screen lengths and 0.010-inch slots. The piezometers include a factory installed sand pack around the well screen. Piezometers will generally be within the floodplain area. Piezometers will be surveyed by a professional surveyor to obtain the data required to generate groundwater elevation maps. Fence posts will be driven into the ground bracketing the piezometers to deter livestock from damaging the piezometers; caps will be placed on the posts.

3.2.2 Sampling Frequency Phase I

Groundwater sampling will be conducted during Phase I and Phase II of the sampling program. Water levels will be measured in all piezometers. Groundwater samples will be collected from each piezometer. Samples will be analyzed for dissolved metals (aluminum, cadmium, iron, manganese, and zinc) calcium, magnesium, and sulfate. Groundwater samples will also be analyzed for iron speciation between the ferrous and ferric states. The groundwater analysis will help establish a knowledge base for evaluating contaminant transport and distribution through the groundwater/surface water interface.

3.2.3 Groundwater Sampling Phase II

Additional piezometers will be installed during the Phase II investigation. Groundwater is expected to be sampled from each of the piezometers. The Phase II piezometers will be screened at various depths depending on site conditions. Six of the piezometers will be in three nested pairs to measure metals in groundwater relative to screened interval. The groundwater samples will be submitted to an EPA CLP laboratory and analyzed for dissolved metals as specified in Section 3.2.2. Anticipated sample locations are displayed on Figures 2 and 3.

As previously described, two to four piezometers will be installed along each transect following the procedure set forth in Appendix A-1, Tetra Tech SOP, *Installation of Monitoring Wells and Piezometers*. Overall depths are assumed to be approximately 10 ft with a 3- or 5-foot screen lengths and 0.010-inch slots.

To ease installation, the piezometers will use Geoprobe® Prepacked Well Screens, or equivalent, designed for setting small diameter monitoring wells. The prepacked screens consist of a standard, slotted PVC well screen pipe surrounded by a stainless steel mesh. Sand is packed between the slotted PVC and the stainless steel mesh. Because the sand is packed around the slotted PVC before the well screen is installed, using prepacks guarantees that sand will be directly around the well screen. That makes well installation quicker and more efficient than traditional methods.

To install monitoring well/piezometers with the prepacks, probe rods are first driven to depth. The well assembly is then lowered into the probe rod string with a threaded PVC riser pipe. Once the well assembly is lowered to the bottom of the probe rod string, the probe rods are retracted to a point above the screen. A sand barrier, directly above the well screen, will be created either by natural formation collapse (occurring during the initial probe rod retraction) or by gravity installation of fine-grade sand through the rod annulus. With the barrier in place, granular bentonite or bentonite slurry is then installed in the annulus to form a well seal. Installation personnel will follow the procedures illustrated in Appendix A-1, Tetra Tech SOP, *Installation of Monitoring Wells and Piezometers*. The piezometers will be surveyed by a professional surveyor as described in Section 5.4. Fence posts or a capped, larger-diameter PVC pipe similar to a well casing will be driven into the ground, surrounding the piezometers to prevent damage from livestock.

The piezometers will be allowed to stabilize for 24-hours before well development. Each well will be developed by purging at least five well volumes with a dedicated bailer. Well development will follow EPA Region 8 protocols set forth in Appendix A-6 SOP #3.2, *Well Development*. The SOP for obtaining water levels is included in Appendix A-7, Tetra Tech SOP, *Water Level, Immiscible Layer, and Well Depth Measurement*. During the Phase II monitoring, groundwater samples will be collected from select piezometers and analyzed for dissolved metals (aluminum, cadmium, iron, manganese, and zinc) calcium, magnesium, and sulfate. Water sampling procedures are described in

more detail in the SOP included in Appendix A-8, EPA ERT SOP No. 2007, *Groundwater Well Sampling*.

3.3 Surface Water and Sediment Sampling

3.3.1 Surface Water Sampling Phase I

Surface water sampling locations will be identified during the Phase I field activities. Surface water and sediment samples will be collected during the second phase of the fieldwork. The surface water and sediment sample collection locations will depend on the results of the qualitative dye tracer study, stream flow measurements and stream cross-sectional dimensions collected during the first phase of field sampling. It is anticipated that approximately 10–20 sample locations will be sampled during Phase II to support the modeling, provided that ample water is in Silver Creek to collect samples. Sampling locations will be placed upstream, downstream, and within each braid of the main Silver Creek channel. Samples will be configured similarly where tributary streams enter the mainstem of Silver Creek. Additional discretionary sample locations will be positioned along the stream in areas bracketing sources or inflows to Silver Creek. Samples will be collected in a downstream order according to the relative travel times observed during the Phase I dye test.

It is anticipated that the volume of water present in Silver Creek will allow for single-point grab surface water samples. The samples will be collected in accordance with EPA ERT SOP No. 2013 (Appendix A-3), modified as follows. Single point grab samples can be collected from streams of very small width, or from larger rivers when access to the river poses a safety concern (i.e., during high flow). Rather than using the sample container to collect the sample (as is specified in the *Direct Method* sample collection section of SOP No. 2013), a secondary container will be used to collect a large volume of surface water, from which the sample aliquots are subsequently generated.

Samples will be collected using a clean/decontaminated gallon container that will be immersed into the stream to collect the sample. If that is not possible, silicon tubing from a GeoTech Geo Pump Series II peristaltic pump outfitted with an EZ-load II pump head will be immersed directly into the water being sampled. Depending on the proximity of the sample locations, samples can be returned to a staging area where the 0.45-micron filtering and sample preservation with nitric acid will take place. If that is not possible, the sample will be filtered and preserved at the sample location. The sample containers will then be labeled and packaged for shipment to the analytical laboratory. The information provided on container labels will include time and date the sample was collected; sampling location; preservative used; initials of the person who collected the sample; and a sample code (e.g., LSC-SW-1). Finally, all sampling activities will be recorded in the field notebook, and all sample locations will be surveyed with GPS equipment, and photographed with a digital camera.

Surface water samples will be tested in the field for pH using an Orion 250A or Orion 261 pH meter, and specific conductance measurements will be taken with a Cole-Parmer 1481-61 or Cole-Parmer CON 400 meter. Field instruments will be calibrated before sampling each day during the field activities. Stream flow and channel dimensions will be taken at surface water and sediment sample locations. Surface water samples will be analyzed by an EPA contract laboratory for total and dissolved metals including aluminum, cadmium, calcium, iron, magnesium, manganese, and zinc. Sulfate and total suspended solids will also be analyzed.

3.3.2 Surface Water Sampling Phase II

During Phase I, Silver Creek was dry in many areas; therefore, surface water or sediment sampling will not be conducted. However, an opportunistic sampling event will be conducted in December

2007 to obtain surface water samples, primarily from the irrigation ditch paralleling LSC to the east. The amended surface water sampling approach identified locations for up to 15 surface water samples. Sample locations were selected based on access constraints. On December 17, 2007, eight surface water samples were taken from the LSC Site. Seven samples were not obtained because of ice over the stream or insufficient stream flow. The surface water samples were analyzed for 23 metals (both total and dissolved) by an EPA CLP lab, and sulfate and iron speciation by ACZ laboratories. Sampling locations are shown on Figures 2 and 3.

Tetra Tech proposes to collect surface water and sediment samples in accordance with the criteria specified in the Appendix A-3, EPA ERT SOP No. 2013, *Surface Water Sampling*, and Appendix A-3, USGS OFR 90-140, *Methods for Collection and Processing of Surface-Water and Bed-Sediment Samples for Physical and Chemical Analyses*. Surface water samples will be collected in downstream order according to the relative travel times observed during the Phase I dye test. Depending on flow conditions, stream sediment samples could be collected on the day(s) following the surface water sampling. Such a practice could be followed to limit turbid water conditions, which can bias analytical results. Sufficient sample quantity (typically 2 liters) will be collected to satisfy the volume requirements for the analyses selected. Flow measurements will be taken following the criteria stated in Appendix A-2, ASTM D3858-95, *Open-Channel Flow Measurement of Water by Velocity-Area Method*.

Tetra Tech proposes to collect sediment samples in accordance with the criteria specified in Appendix A-9, USGS OFR 90-140, *Methods for Collection and Processing of Surface-Water and Bed-Sediment Samples for Physical and Chemical Analyses*. Sufficient sample quantity (typically 4 ounces) will be collected to satisfy the volume requirements for the analyses selected.

3.3.3 Sediment Sampling Phase I

Sediment samples will be collected at the surface water sample locations to evaluate the concentration of total metals. The samples will be collected with a decontaminated stainless steel scoop or disposable plastic scoop and placed in the appropriate sample container, typically a 4-ounce glass jar. The sample containers will then be labeled and packaged for shipment to the analytical laboratory. The information provided on container labels will include time and date the sample was collected; sampling location (which will correspond with the surface water sample); initials of the person who collected the sample; and a sample code. All sampling activities will be recorded in the field notebook, surveyed with GPS equipment, and photographed with a digital camera.

Sediment samples will be analyzed by an EPA laboratory for total metals including aluminum, cadmium, calcium, iron, magnesium, manganese, sulfate, and zinc. A partial digestion will be performed on sediment samples. Samples will be exposed to a solution of warm 2M HCl-1% H₂O₂ and then analyzed by inductively coupled plasma atomic emission spectroscopy (ICP-AES). The partial digestion will dissolve hydrous amorphous iron and manganese oxide and provide the concentration of trace elements bound in potentially available phases. A total digestion of sediment (for cadmium, iron and zinc) will be performed to quantify refractory (resistant) sulfide mineral

A map showing surface water and sediment sample locations will be produced after the Phase I field activities are complete. Surface water and sediment samples will be one-time grab samples at each location.

3.4 Wetlands Delineation

As part of the proposed federal and Utah assisted cleanup of heavy metals associated with historic mining actions in the upper portions of the Silver Creek watershed and surrounding drainages, wetlands within the project area would require delineation. The project area is largely undeveloped pastureland and grasslands adjacent to a mix of residential and commercial properties in the growing Park City/Snyderville Basin area. The project area is known to contain wetlands, with approximately 10 percent of the area previously delineated and mapped by the Natural Resources Conservation Service National Wetland Inventory. Because of its proximity to known wetlands and Silver Creek, the majority of the project area is anticipated to be in an area with high wetland potential. The jurisdictional status of National Wetland Inventory and high wetland potential areas is unknown.

Because cleanup efforts proposed for the project area would likely affect any wetlands present within its borders, the U.S. Army Corps of Engineers (USACE) will require a comprehensive evaluation, in the form of wetland delineation, for the entire project area (including previously delineated areas). Tetra Tech scientists experienced with identifying wetland functions as they relate to jurisdictional status will delineate the wetlands. Information collected in the field will include the following: vegetative characteristics, soil type, geographic location, and hydrologic setting. Coordination with the Utah Regulatory Office will determine the final approach to be used for delineations. It is anticipated that the Routine Approach, Level 2 Onsite Inspection as described in the 1987 USACE *Wetlands Delineation Manual* (Appendix B) will be used. Wetland delineations will be conducted in accordance with the 1987 U.S. Army Corps of Engineers *Wetland Delineation Manual* (Appendix B) and U.S. Army Corps of Engineers *Draft Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys and Coast Region* (Appendix C; USACE 2007).

Briefly, that method will include the following:

- Determining site conditions
- Identifying plant community types
- Selecting observation points (quadrates)
- Characterizing plant community types and determination of hydrophytic vegetation status
- Determining presence of wetland hydrology and hydric soils
- Performing wetland boundary delineation and surveys with GeoXT submeter GPS units

If required by the Utah Regulatory Office, Tetra Tech is also capable of using the Draft Interim Regional Supplement to the Corps of Engineers *Wetland Delineation Manual: Western Mountains, Valleys and Coast Region* (Appendix C). For the planning purposes, it is estimated that the field reconnaissance will require four to six field biologists up to 4 weeks to perform the on-site wetland delineations. The field evaluations will identify both jurisdictional and isolated wetlands.

In the likely event that a USACE Clean Water Act section 404 permit is required for cleanup-related actions in the project area, the USACE could require a wetlands functions and values assessment. That assessment will be conducted concurrently with other delineation. That prevents the need for a second mobilization of field technicians or delays until site conditions are suitable to conduct the assessment. Though specific methodology will be developed in coordination with the USACE, Tetra Tech proposes to use the Montana Department of Transportation Montana Wetland Assessment

method (Berglund 1999) to evaluate wetland functions and values. This methodology is applicable, because Utah has not adopted a wetland functions and values assessment method.

4. SAMPLE DESIGNATION

Water samples will be labeled using their location/site identification and the date of collection. The location name (well, surface water station, and the like) is to be followed by a hyphen and the date in six-digit format (MMDDYY). For example, a groundwater sample collected from Well MW-7 on June 30, 2007 would be identified as MW7-063007 on the sample label. A surface water sample collected from Silver Creek Station 1 on August 15, 2007 would be identified as SC1-081507.

Field duplicate samples will be designated with a *D* after the sample location. Equipment rinsate samples will be designated with an *ERB* as the sample location, followed by the date as described previously. Sample aliquots collected for laboratory QA/QC analyses will be given the same identification as the primary sample and noted on the chain of custody as “extra bottles for QA/QC analyses.”

5. SAMPLING EQUIPMENT AND PROCEDURES

5.1 Sample Documentation

At each sample collection location, the following information will be recorded in the field logbook or on a designated field form:

- Names of field personnel
- Date/time of measurement
- Measurement identification location (e.g., transect, station)
- GPS coordinates
- General weather conditions (e.g., hot, windy, no precipitation)
- Soil description, including color and texture (e.g., red-brown, sandy silt with occasional gravel) and relative moisture content (e.g., dry, moist, wet)
- Description and location of mine/mill related materials, if visually present on or adjacent to the trail
- Description and location of nearby features (e.g., shafts, building foundations, cribbing), if visually present
- Description and location of water drainage paths, if present near the measurement location
- General description of adjacent vegetation conditions
- Soil sample identification, sample collection location, and collection time, if sample is collected
- Any problems encountered or deviations in sample collection methods
- Description of any unusual circumstances
- Photo documentation details, if necessary

5.2 Sampling Equipment Decontamination

Decontamination procedures will be conducted in accordance with the guidance provided in the Appendix A-5, EPA SOP No. 2006, *Sampling Equipment Decontamination*. Reusable sampling equipment will be decontaminated between each sample collection using the following procedure:

- Each item will be scrubbed with a brush using tap water and a low-phosphate detergent
- After gross decontamination, each item will be rinsed three times with distilled/deionized water
- Each item will then be rinsed with a 10 percent nitric acid solution
- After the item has dried, it will be given a final rinse with distilled/deionized water
- Decontamination fluids will be returned to the ground in accordance with guidance provided in Appendix A-10, EPA Region 8 SOP #1.6.5, *Handling of Investigation-Derived Waste*

Decontamination procedures will be carefully conducted to ensure that contamination is neither introduced externally during the sampling process nor transferred by cross-contamination between sample locations. Cleaned equipment will be bagged between sampling stations to avoid environmental contamination. Personnel involved in sampling equipment preparation, sample collection, and processing will wear nitrile gloves to protect themselves and to minimize the opportunity for sample contamination.

The Geoprobe and related equipment will be decontaminated at a location within the site boundaries.

Geoprobe decontamination will be conducted before drilling, between borehole locations, and after the final borehole is completed. Equipment to be decontaminated will include the back of the geoprobe, drilling rods, drill bits, wrenches, and such. The geoprobe equipment will be decontaminated by the geoprobe subcontractor under the supervision of Tetra Tech. The specific procedure is as follows:

- Gross contamination (i.e., soil, mud) will be removed by washing with potable water and nonphosphate detergent. Any equipment with loose paint chips or that is badly rusted will be scrubbed with a wire brush before cleaning,
- Once all visible contaminants are removed, a final rinse with potable water will be performed.
- The decontamination water generated from the drill rig and related equipment will be allowed to run onto the ground within the boundaries of the site.

5.3 Investigation Derived Waste

Investigation derived wastes (IDW) generated during the course of the field activities (e.g., decontamination water, personal protective equipment (PPE), and disposable sampling equipment) is expected to be minimal. Nevertheless, the wastes will be treated as Resource Conservation and Recovery Act (RCRA) hazardous or nonhazardous materials, as appropriate, and managed according to the criteria established in the Appendix A-10, EPA Region 8 SOP #1.6.5, *Handling of Investigation-Derived Waste*. It is expected that the IDW generated during site activities will be limited to decontamination water (both from hand tools and auger flights), latex gloves, and other PPE. PPE will be rinsed before disposal and sent to a municipal sanitary landfill. The decontamination water will be returned to the ground so as not to migrate off-site.

5.4 Surveying

Surveying of all surface water and soil sample locations will be performed by Tetra Tech personnel with handheld GPS units. Professional surveyors will be subcontracted to survey the piezometer installations. Survey for the wetlands delineation will be performed using a GeoXT submeter GPS unit.

6. SAMPLE HANDLING AND CUSTODY PROCEDURES

Each sample will be properly labeled in the field. Ziploc bags will be checked for proper seal (reseal or re-bag any leaking bags). Samples will be double-bagged to prevent cross contamination and to provide additional padding during shipment. Samples will be individually entered by sample number on the chain-of-custody form. After collection, individual samples will be placed in a cooler or other suitable container for storage in the field. Samples will be shipped to the laboratory in a cooler with ice. The ice in the cooler will be double-bagged. One copy of the chain-of-custody form will be enclosed in a plastic bag in each cooler containing the samples identified on the form. Chain-of-custody protocol will be maintained for samples from the time of collection until their final deposition. The cooler will be taped shut, and custody seals will be attached to the outside of the cooler to ensure that the cooler cannot be opened without breaking the seal. The cooler will be shipped using an authorized shipping service or hand delivered to the laboratory for analysis.

Duplicate samples will be collected and submitted to the laboratory to ensure the precision and reproducibility of sample collection procedures. In addition, duplicate XRF measurements will be performed as described previously. Duplicate samples will be collected for approximately 10 percent of the total samples. Duplicates will represent a split of the sample collected in the field to capture any variability in the field homogenization procedures. The duplicate samples will be preserved, packaged, and handled in the same manner as the primary samples. No equipment blanks or field blanks will be collected.

A field log book will be maintained to document all sampling activities. All notes will be made in indelible ink. Entries on each page will be initialed at the end of each page by the sampling crew member who entered the information. If any changes are made to the record, the original notation will be crossed out with a single line and initialed. Information to be recorded in the log book or on a designated field form is described in Section 5.0.

7. FIELD AND LABORATORY TESTING METHODS

A variety of environmental media collected during Phase I and Phase II field activities will be sampled and transferred to the laboratory for analysis. These media include the following:

- Soils
- Groundwater
- Surface Water
- Bed Sediment

Aqueous (groundwater and surface water) samples will be tested in the field for pH, specific conductance, and temperature using EPA Methods 150.1 (pH), 120.1 (Specific Conductance), and 170.1 (Temperature).

Analytes for surface water samples including dissolved and total metals, and major cations and anions, will be tested by the EPA laboratory following analytical methodologies in EPA Methods 200.7, 200.8, and 375.3.

Soils pH analysis will be performed by Colorado Analytical according to the criteria specified in Appendix A-11, ASTM D4972-95a, *Standard Test Method for pH of Soils*. The University of Colorado's LEGS will perform mineralogical analyses according to the procedure outlined in Appendix A-12, University of Colorado, *Metal Speciation SOP*.

Upon completion of sample collection, the soil samples will be shipped to Colorado for XRF analysis. The analysis will quantify soil metal concentrations for arsenic, cadmium, lead, and zinc. The SOP for XRF analysis is in Appendix A-13, Tetra Tech SOP, *XRF Soil and Sediment Analysis*.

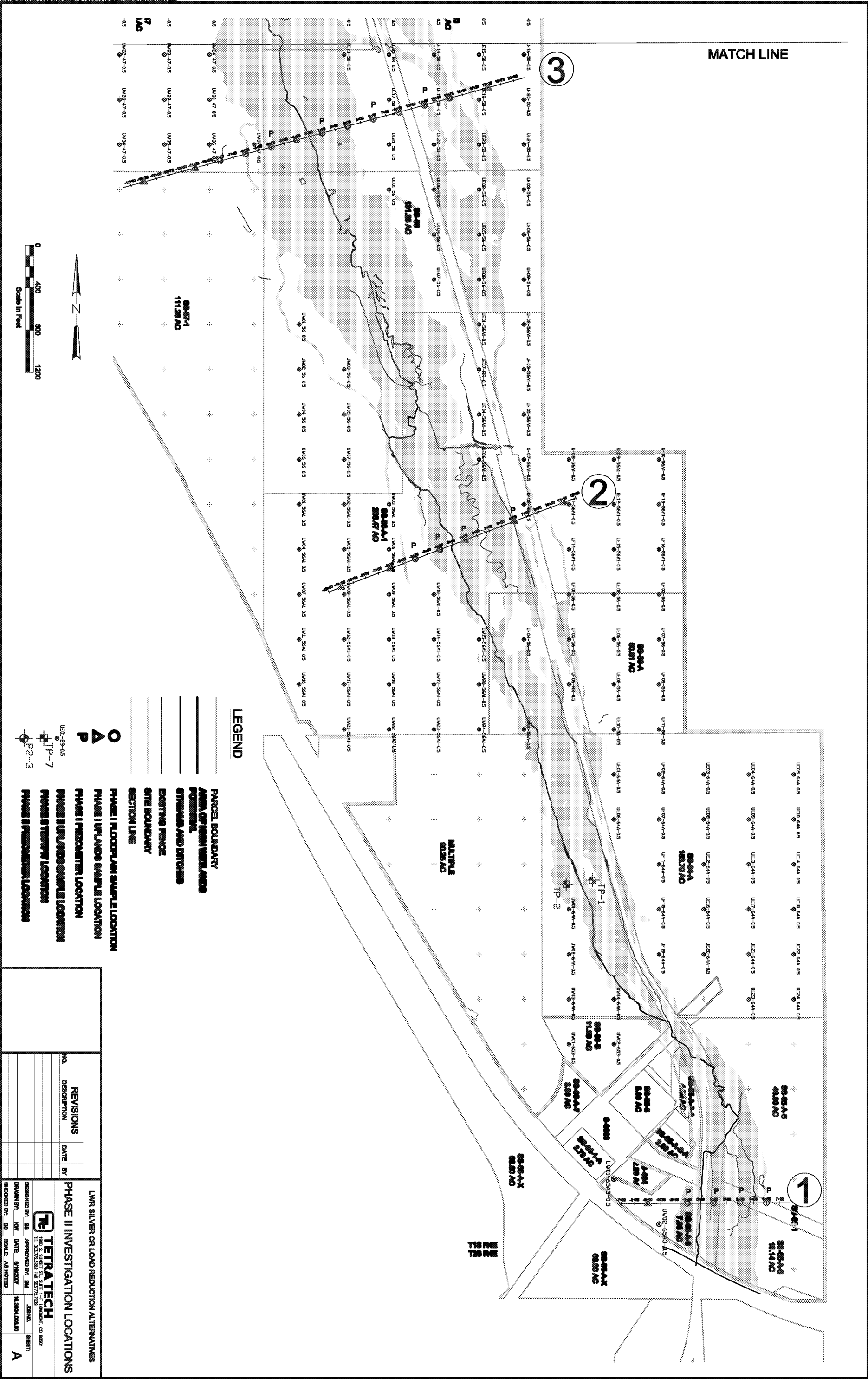
8. REFERENCES

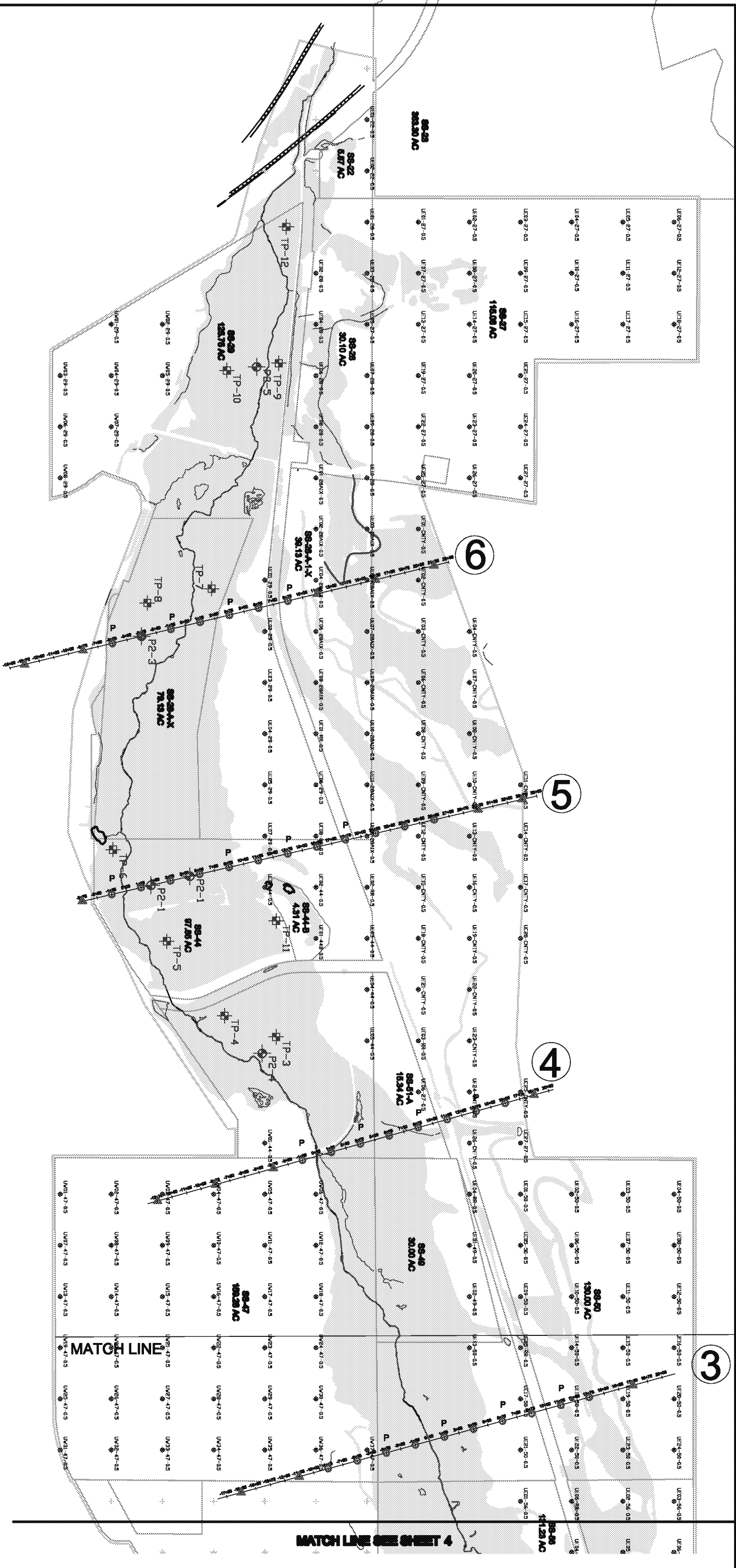
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LEGEND

- PARCEL BOUNDARY
AREA OF HIGH WINDS
POTENTIAL
STORMS AND DITCHES
EXISTING FENCE
SITE BOUNDARY
SECTION LINE
PHASE I FLOODPLAIN SAMPLE LOCATION
PHASE I UPLANDS SAMPLE LOCATION
PHASE I WINDMETER LOCATION
PHASE I UPLANDS COWPLOT LOCATION
PHASE I TERRESTRIAL LOCATION
PHASE I POND/SHOAL LOCATION

[illegible]